

**Monitoring the Critical Zone using Time-Lapse Digital Photography.** Within the critical zone, important interconnected physical, chemical, and biological processes influence the mass and energy exchange that governs everything from biomass production to water storage. However, many of these processes operate on different temporal and spatial scales, and little is known about how these processes interact. We have begun to quantitatively link these processes by analyzing time-lapse digital images. These images also have the potential to link processes across different disciplines, such as snow hydrology and ecology.



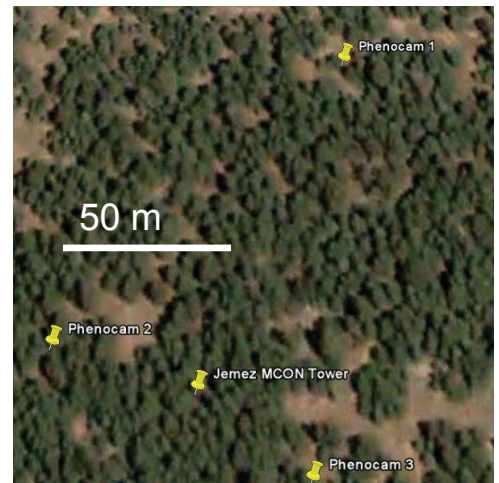
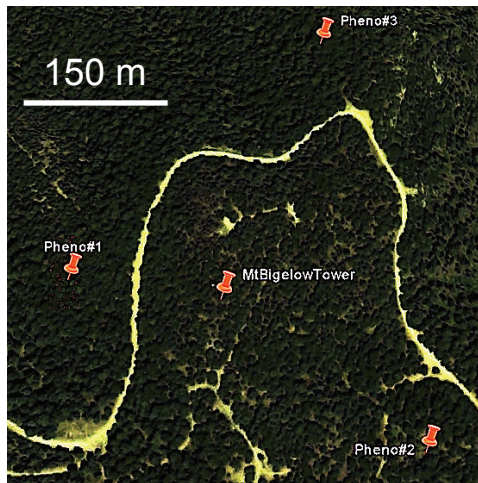
### Santa Catalina Mountains:

Co-located with Mount Bigelow Tower tower managed by G. Barron-Gafford  
Elevation ~ 2,500 m  
Mixed Conifer Woodland

### Jemez River Basin:

Co-located with Mixed Conifer Tower tower managed by M. Litvak  
Elevation ~ 3,000 m  
Mixed Conifer Woodland

**Approach.** At the Mount Bigelow eddy covariance tower in the Santa Catalina Mountains, and at the Mixed Conifer eddy covariance tower in the Jemez River Basin, we mounted a single overstory “tower-cam” just above the Li-Cor 7500 CO<sub>2</sub>/H<sub>2</sub>O IRGA and three understory “pheno-cams” at heights of 1 m within the footprint of the towers. All four cameras record images hourly.



#### Understory Cameras:

- Moultrie M60 Game Cameras
- Focal length: 20 to 45 ft
- Resolution: 6 MP
- Power: 6 D-Cell Batteries
- Orientation: North
- Positioned 1 m above the ground
- Mounted to trees with bolts
- Images downloaded ~monthly

#### Snow/Vegetation Stakes:

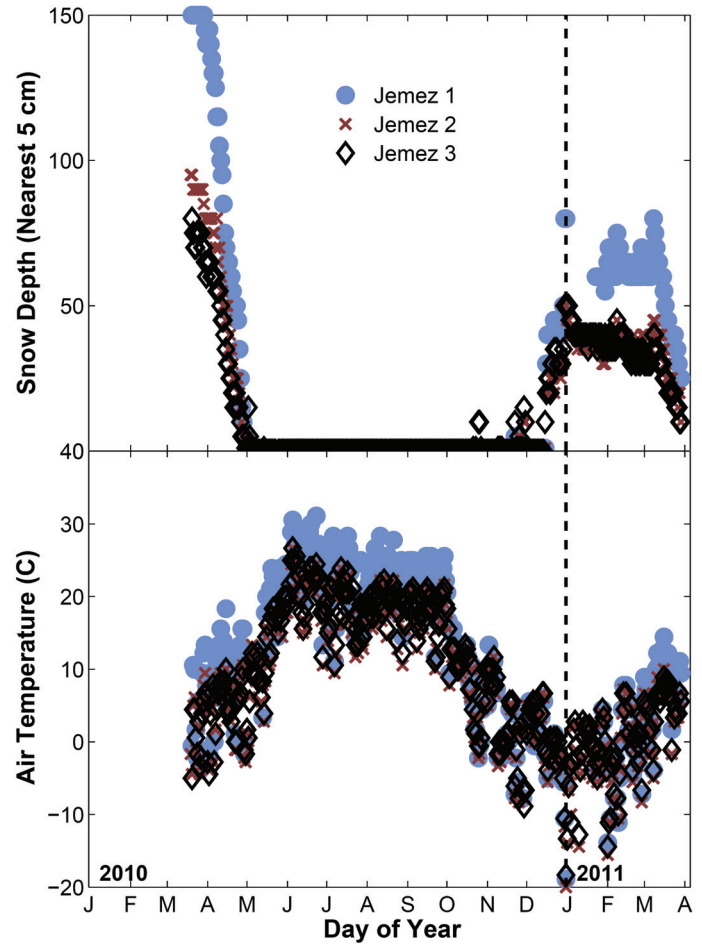
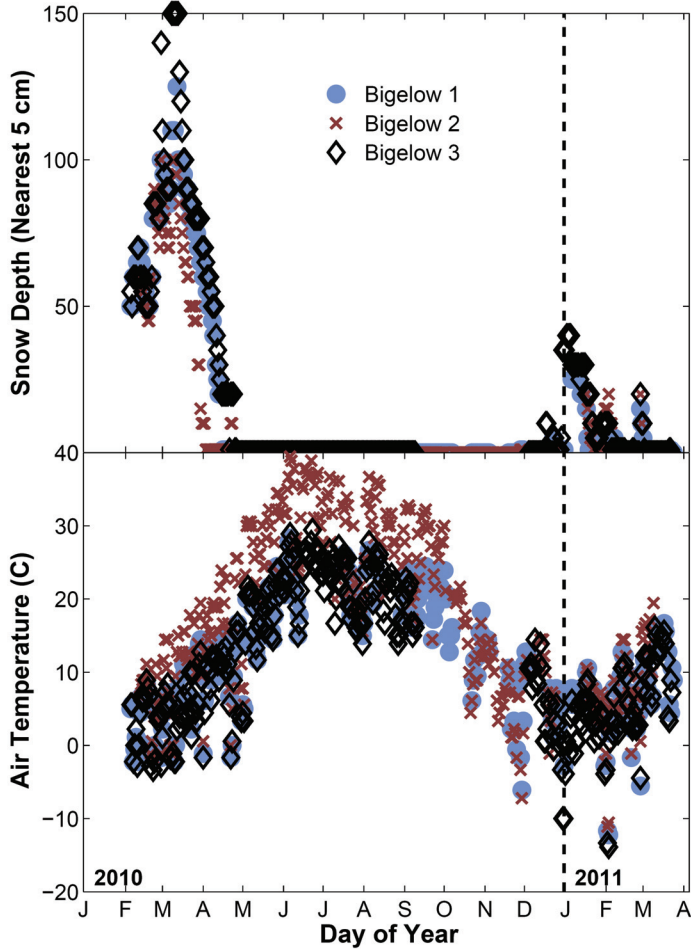
- Added in hindsight
- Placed in frame of under story cams
- Positioned straight up using levels
- Red and white stripes alternate 5cm

#### Overstory Cameras:

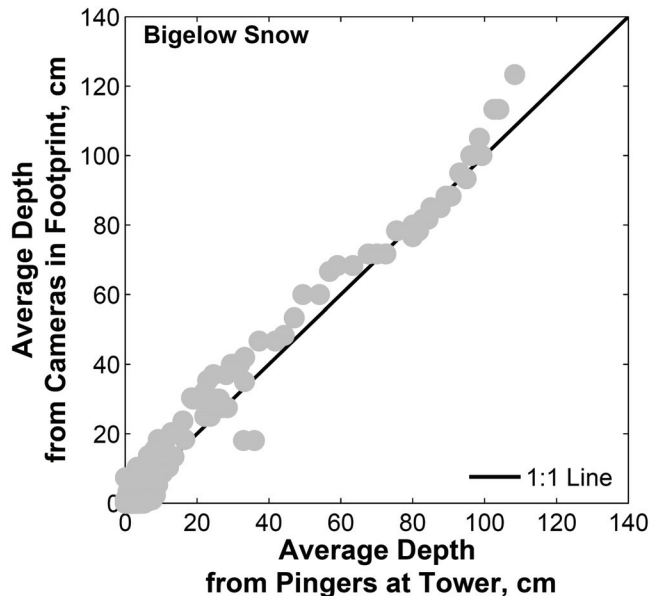
- StarDot NetCam XL
- modified to save images to data card
- Focal length: 0.2m to ∞
- Resolution: 3 MP
- Power: Solar Panel/Marine Battery
- Orientation: into main wind
- Mounted just above LiCor-7500
- Images downloaded ~ monthly



**Understory Digital Image Derived Snow Cover.** The interannual variability of snow cover is captured with the understory digital images at both the Santa Catalina Mountains Bigelow tower and the Jemez Mixed Conifer tower sites. Also, site to site differences can be evaluated. At Bigelow, the warmest camera has the least amount of snow, while at Jemez the warmest camera has the most amount of snow. Going back to the actual images helps us to understand what is driving these snow conditions.

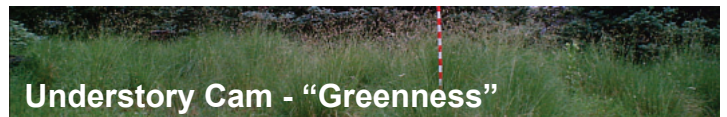


**An Inexpensive Alternative for Snow Depth.** The cost of an installed understory game camera is about \$300, including batteries, memory card, and mounting supplies; the cost of a traditional snow sensor is about \$700 which does not include the price of the datalogger, deep cycle marine battery and solar panel. Given the close agreement between the depth obtained by both methods, the understory camera appears to be a viable and inexpensive alternative.



**Using the Images to Quantify Greenness and Albedo.**

Understory images are being analyzed for greenness to evaluate the contribution of the understory to CO<sub>2</sub> uptake. Overstory images are being analyzed for whiteness to evaluate the contribution of snow to the albedo of the area.



**Contact.** For collaboration or to learn more about these time-lapse digital cameras, please contact:

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Archived images and movies may be obtained from the JRB-SCM CZO website: [www.czo.arizona.edu](http://www.czo.arizona.edu)